Prediction of 2024 US election ...*

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We forecast the winner of the 2024 US presidential election using "poll-of-polls" by building a linear model.

```
cleaned_data = read_csv(here("data/02-analysis_data/cleaned_data.csv"))
```

```
Rows: 1732 Columns: 13
-- Column specification --------------------------------------------------------
Delimiter: ","
chr  (4): pollster, methodology, state, candidate_name
dbl  (7): poll_id, pollster_id, question_id, sample_size, pollscore, days_ta...
date (2): end_date, start_date

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

1 Introduction

Election result forecasting has become an essential tool for analysts in political science and the public to predict the outcome of democratic process, such as the presidential election in the United States. Traditionally, individual polls have been used as a snapshot of voter sentiment, but they only reflect temporary changes in the performance of contestants, instead of a precise estimation of the election result. As discussed by Pasek (2015) and Blumenthal (2014), the aggregation of multiple polls, or "poll-of-polls," has become a popular technique to reduce individual survey errors and provide more accurate election forecasts. However, the traditional poll aggregation does not reflect dynamics of an election, especially with real-time changes and the introduction of new data. This creates a gap for a more adaptable model

*Code and data are available at: https://github.com/yulexun/uselection.

to predict the election result based on both polling data and additional variables, such as historical data and economic indicators.

This paper fills the gap by building a hybrid election forecasting model following the strategies mentioned by Pasek (2015). As Pasek (2015) described in their article, aggregation involves determining which surveys are worth including, as well as selecting, combining and averaging results from multiple polls to reduce individual biases and errors. Prediction modeling adds other data to the model that predicts election outcomes based on current dynamics. Hybrid models like the Bayesian approach incorporates prior beliefs based on historical data or expert knowledge and new evidence like economic updates to dynamically adjust the forecast as the campaign progresses.

In this paper, we aim to predict the 2024 us election result with the hybrid election forcasting model. We incorporate aggregation by filtering the polls on FiveThirtyEight (2024) by numeric grade that indicates pollster's reliability, prediction that incorporates social and economic indicators including unemployment rates and abortion rates, and hybrid approaches that leverages Bayesian techniques which combines historical data such as the 2016 election data, allowing for a dynamic prediction of the U.S. presidential election.

The estimand for this research paper is the predicted support percentages for Kamala Harris and Donald Trump. The prediction is based on quantifying various polling factors, including sample size, poll scores, and transparency scores, which are used as predictors.

The results of this model indicate a more stable and accurate forecast compared to traditional aggregation methods alone, [update this ...]

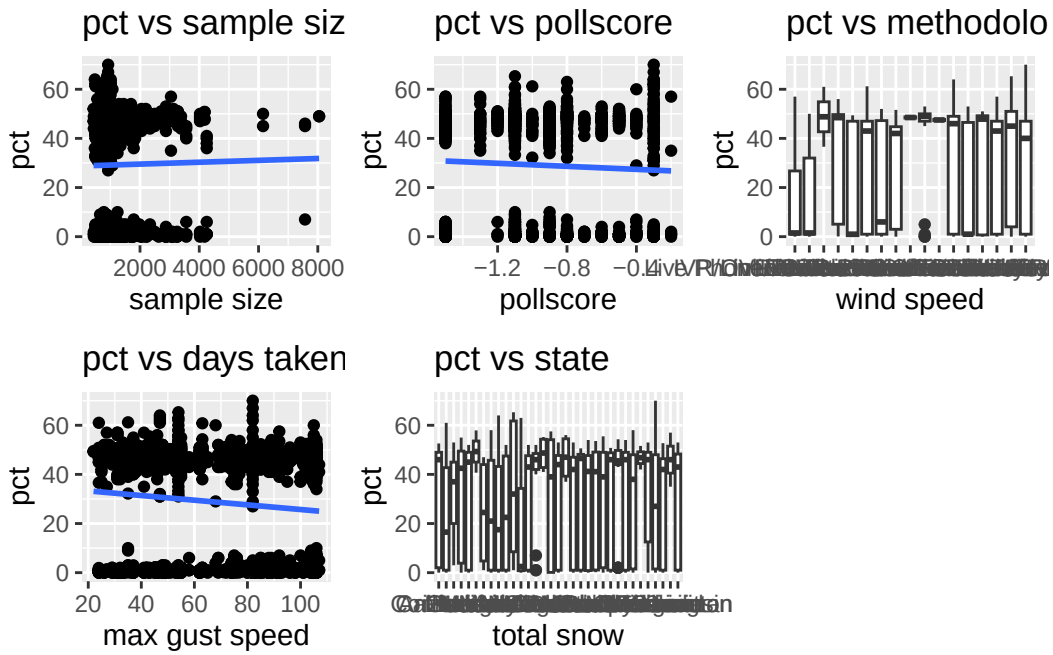
The remainder of this paper is structured as follows: [update this ...]

2 Data

2.1 Overview

For the data we used in this analysis about the polling result for Kamala Harris and Donalad Trump in 2024 USA president election.
- **response variable:** `pct`(pct: The percentage of the vote or support that the candidate received in the poll)
- **numeric predictor:**
`sample size`(sample_size: The total number of respondents participating in the poll)
`timegap`(the time gap between the poll start date and the real election date i.e timegap = real US election date - poll start date)
`pollscore`(A numeric value representing the score or reliability of the pollster in question)
- **categorical predictor** `state`(The U.S. state where the poll was conducted or focused)
`methodology`(The method used to conduct the poll)

Table 1



2.2 Explore the data

pct vs sample size:

- pct vs sample size:

This scatter plot shows the pct against the sample size, with a fitted trend line indicating a slight positive relationship. The data points are denser for lower sample sizes, suggesting that smaller sample sizes are more common in the dataset.

- pct vs pollscore:

This scatter plot illustrates the pct against pollscore. The fitted trend line suggests a weak negative relationship between pollscore and pct. The points are scattered without a strong linear pattern.

- pct vs methodology:

A boxplot comparing pct for different polling methodologies. The pct distribution varies across methodologies, with some showing greater spread or median differences. This suggests that the polling methodology may influence pct outcomes.

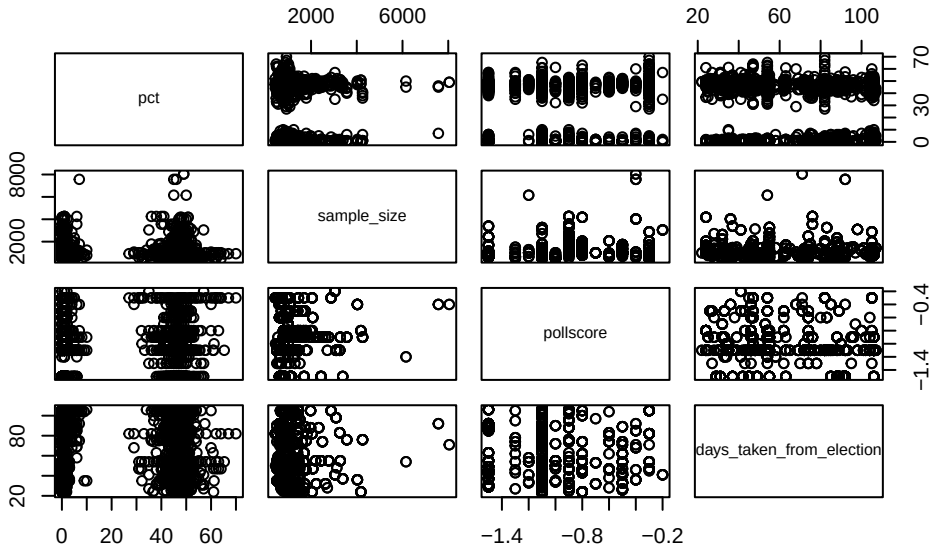
- pct vs days taken from election:

A scatter plot displaying pct versus the number of days before the election. The trend line indicates a slight negative relationship, suggesting that as the election date approaches, pct may decrease slightly.

- pct vs state:

A boxplot depicting pct across different states. The pct distribution varies by state, with some states showing wider variability or different median values, implying state-specific effects on pct.

```
# numeric_data <- cleaned_data[sapply(cleaned_data, is.numeric)]
numeric_data = cleaned_data |> select(pct, sample_size, pollscore, days_taken_from_election)

# Create the pairs plot
pairs(numeric_data)
```



The pairs plot displays scatter plots of four numeric variables (`pct`, `sample_size`, `pollscore`, and `days_taken_from_election`) to visualize their relationships. The data shows clustering, particularly in `pct` versus `sample_size`, suggesting potential heteroscedasticity. The `sample_size` variable is skewed towards lower values, while `pollscore` and `days_taken_from_election` have a more even spread, though `pollscore` shows central clustering. No strong linear relationships are immediately apparent between the variables, indicating that correlations are likely weak. Further statistical analysis would be beneficial to better understand these relationships and confirm any potential patterns.

2.3 Measurement

In this dataset, each row represents a polling question that records the variables of interest. Each entry allows us to explore the real-world relationships between polling factors and the support percentage (`pct`) for the candidates Kamala Harris and Donald Trump. This dataset enables an analysis of how various polling characteristics influence the reported support levels for the candidates we are focused.

2.4 Clean Data

The data cleaning process involves several steps to ensure the quality and relevance of the polling data. First, we filter the dataset to retain only poll results with a numeric grade of 2.7 or higher, indicating that the polls are considered reliable. Next, we address missing values in the state attribute: polls with NA in the state column are considered national polls.

We then create a new attribute, days_taken_from_election, which represents the time gap between the poll's start date and the actual U.S. election date. Additionally, we filter the dataset to include only polls conducted after July 21, 2024, the date when Kamala Harris declared her candidacy. Finally, we remove any remaining rows that contain missing values to ensure a clean dataset.

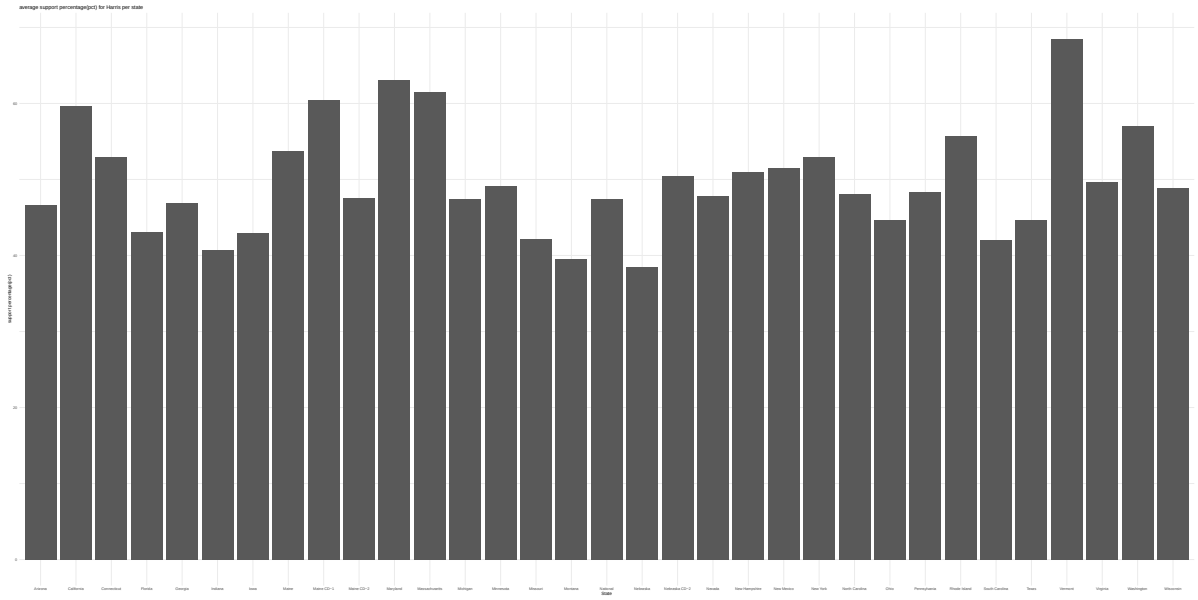
Table 2: Sample of cleaned US election data

pct	sample_size	pollscore	days_taken_from_election	state	methodology	candidate_name
47.6	4180	-0.8	24	National	Online Ad	Kamala Harris
50.7	4180	-0.8	24	National	Online Ad	Donald Trump
0.8	4180	-0.8	24	National	Online Ad	Jill Stein
0.1	4180	-0.8	24	National	Online Ad	Chase Oliver
0.1	4180	-0.8	24	National	Online Ad	Cornel West
48.1	4180	-0.8	24	National	Online Ad	Kamala Harris

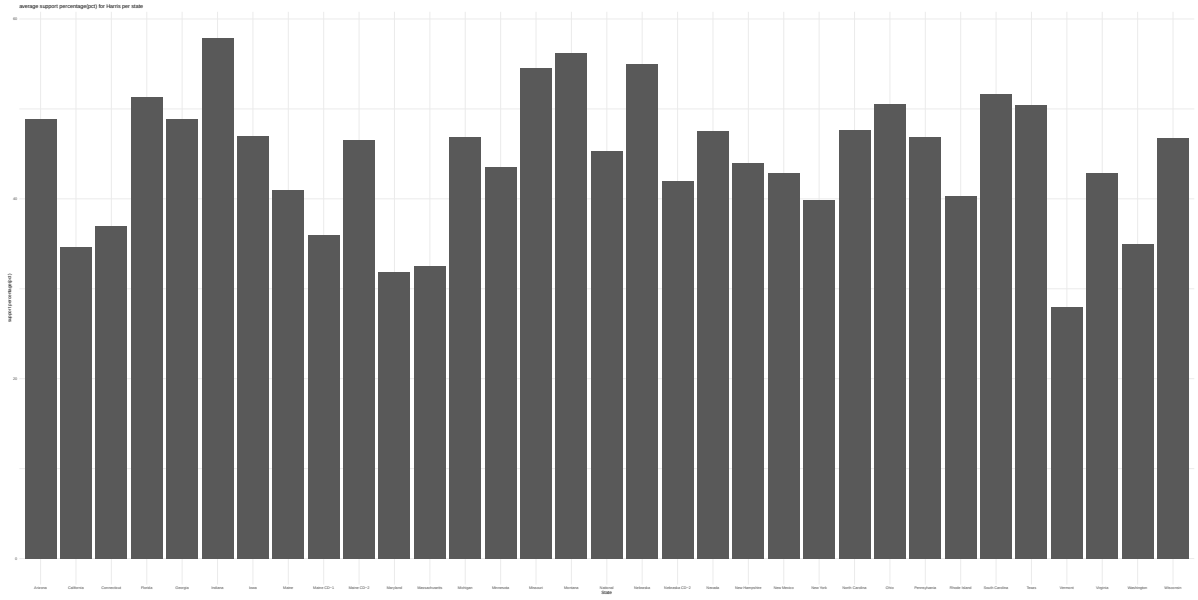
2.5 Basic Statistics Summary for Data

3 Model

The goal of our modelling strategy is twofold. Firstly,...



(a) average PCT vs State for Harris



(b) PCT vs State for Trump

Figure 1: the average PCT vs State for Harris and Trump

Here we briefly describe the Bayesian analysis model used to investigate... Background details and diagnostics are included in Appendix B.

3.1 Model set-up

Define y_i as the number of seconds that the plane remained aloft. Then β_i is the wing width and γ_i is the wing length, both measured in millimeters.

$$y_i|\mu_i, \sigma \sim \text{Normal}(\mu_i, \sigma) \tag{1}$$
$$\mu_i = \alpha + \beta_i + \gamma_i \tag{2}$$
$$\alpha \sim \text{Normal}(0, 2.5) \tag{3}$$
$$\beta \sim \text{Normal}(0, 2.5) \tag{4}$$
$$\gamma \sim \text{Normal}(0, 2.5) \tag{5}$$
$$\sigma \sim \text{Exponential}(1) \tag{6}$$

We run the model in R (R Core Team 2023) using the `rstanarm` package of (**rstanarm?**). We use the default priors from `rstanarm`. us

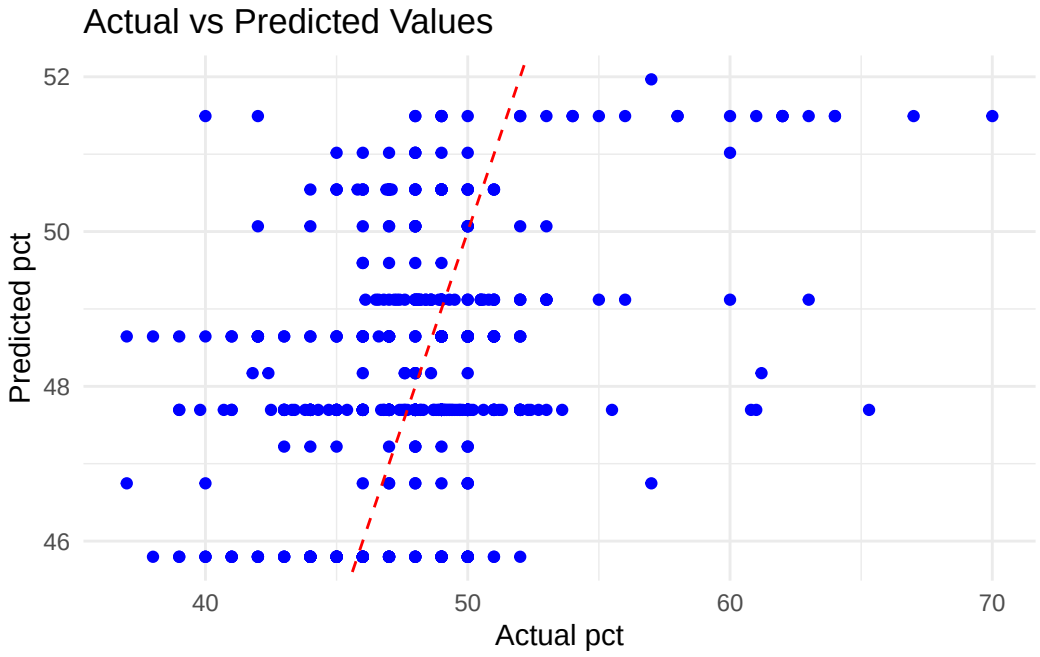
3.2 Basic Model

```
just_harris_data = Harris_data |> na.omit()
lm_model1 = lm(pct ~ pollscore, data = just_harris_data)
predictions = predict(lm_model1, just_harris_data)
summary(lm_model1)
```

```
Call:
lm(formula = pct ~ pollscore, data = just_harris_data)

Residuals:
    Min      1Q  Median      3Q     Max
-11.645  -2.069   0.203   1.899  18.508

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  52.9164     0.5428  97.486   <2e-16 ***
pollscore     4.7463     0.5127   9.257   <2e-16 ***
```

```
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3.903 on 516 degrees of freedom
Multiple R-squared:  0.1424,    Adjusted R-squared:  0.1408
F-statistic: 85.69 on 1 and 516 DF,  p-value: < 2.2e-16
```

```r
ggplot(just_harris_data, aes(x = pct, y = predictions)) +
  geom_point(color = 'blue') +
  geom_abline(intercept = 0, slope = 1, linetype = "dashed", color = "red") +
  labs(title = "Actual vs Predicted Values",
       x = "Actual pct",
       y = "Predicted pct") +
  theme_minimal()
```




```r
just_harris_data = Harris_data |> na.omit()
model_MLR = lm(pct ~ pollscore + days_taken_from_election + methodology + sample_size + state
summary(model_MLR)
```

```
Call:
lm(formula = pct ~ pollscore + days_taken_from_election + methodology +
    sample_size + state, data = just_harris_data)
```

```
Residuals:
    Min      1Q  Median      3Q     Max
-9.0969 -1.1595  0.0562  1.5570  7.0946

Coefficients:
```

	Estimate
(Intercept)	44.1277725
pollscore	0.6957470
days_taken_from_election	-0.0286633
methodologyIVR	4.3755995
methodologyIVR/Online Panel	4.5408555
methodologyIVR/Online Panel/Text-to-Web	5.6053696
methodologyIVR/Text-to-Web	2.8861250
methodologyLive Phone	3.8742115
methodologyLive Phone/Email	5.0393270
methodologyLive Phone/Online Panel	0.7687499
methodologyLive Phone/Online Panel/Text	6.0152341
methodologyLive Phone/Online Panel/Text-to-Web	6.1643495
methodologyLive Phone/Probability Panel	4.8917595
methodologyLive Phone/Text-to-Web	5.3247727
methodologyLive Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone	5.1159380
methodologyOnline Ad	4.4724863
methodologyOnline Panel	4.3020832
methodologyOnline Panel/Text-to-Web	5.4176519
methodologyProbability Panel	4.3784976
sample_size	0.0001966
stateCalifornia	13.5880559
stateConnecticut	5.4946250
stateFlorida	-3.6166529
stateGeorgia	0.3471056
stateIndiana	-6.7288415
stateIowa	-2.6335576
stateMaine	7.3774201
stateMaine CD-1	14.2434871
stateMaine CD-2	1.2510054
stateMaryland	15.1021065
stateMassachusetts	14.4818410
stateMichigan	1.1601060
stateMinnesota	3.4353532
stateMissouri	-4.1448797
stateMontana	-6.6623737
stateNational	1.0112185

stateNebraska	-8.7907865
stateNebraska CD-2	4.1641888
stateNevada	1.4087338
stateNew Hampshire	4.4437365
stateNew Mexico	4.8666391
stateNew York	6.4186360
stateNorth Carolina	1.4900945
stateOhio	-2.4899589
statePennsylvania	1.7969108
stateRhode Island	8.3684246
stateSouth Carolina	-1.6078727
stateTexas	-2.1479128
stateVermont	22.3712259
stateVirginia	3.6823360
stateWashington	10.1103450
stateWisconsin	2.5434848
	Std. Error
(Intercept)	2.9822092
pollscore	0.4343844
days_taken_from_election	0.0046950
methodologyIVR	3.8898588
methodologyIVR/Online Panel	3.3520078
methodologyIVR/Online Panel/Text-to-Web	2.9551790
methodologyIVR/Text-to-Web	3.2298723
methodologyLive Phone	2.9378279
methodologyLive Phone/Email	3.0714528
methodologyLive Phone/Online Panel	3.5027886
methodologyLive Phone/Online Panel/Text	3.7510016
methodologyLive Phone/Online Panel/Text-to-Web	2.9572494
methodologyLive Phone/Probability Panel	3.7585229
methodologyLive Phone/Text-to-Web	2.9423181
methodologyLive Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone	3.4002360
methodologyOnline Ad	2.9411956
methodologyOnline Panel	2.9374017
methodologyOnline Panel/Text-to-Web	2.9194457
methodologyProbability Panel	2.9113364
sample_size	0.0001615
stateCalifornia	1.7481502
stateConnecticut	2.4005692
stateFlorida	0.8538744
stateGeorgia	0.5745183
stateIndiana	2.4430457
stateIowa	2.3860179

stateMaine	1.3448331
stateMaine CD-1	1.3505224
stateMaine CD-2	1.3511221
stateMaryland	1.1865952
stateMassachusetts	1.2623777
stateMichigan	0.5900257
stateMinnesota	1.0583496
stateMissouri	1.7395350
stateMontana	1.0602866
stateNational	0.5010647
stateNebraska	1.7420707
stateNebraska CD-2	1.0871315
stateNevada	0.7520971
stateNew Hampshire	1.0173114
stateNew Mexico	1.4344565
stateNew York	1.1451673
stateNorth Carolina	0.5531490
stateOhio	0.8912255
statePennsylvania	0.5241319
stateRhode Island	1.4420034
stateSouth Carolina	3.0728726
stateTexas	0.8318991
stateVermont	1.7728897
stateVirginia	1.0672606
stateWashington	2.4059846
stateWisconsin	0.5706889
	t value
(Intercept)	14.797
pollscore	1.602
days_taken_from_election	-6.105
methodologyIVR	1.125
methodologyIVR/Online Panel	1.355
methodologyIVR/Online Panel/Text-to-Web	1.897
methodologyIVR/Text-to-Web	0.894
methodologyLive Phone	1.319
methodologyLive Phone/Email	1.641
methodologyLive Phone/Online Panel	0.219
methodologyLive Phone/Online Panel/Text	1.604
methodologyLive Phone/Online Panel/Text-to-Web	2.084
methodologyLive Phone/Probability Panel	1.302
methodologyLive Phone/Text-to-Web	1.810
methodologyLive Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone	1.505
methodologyOnline Ad	1.521

```
methodologyOnline Panel                                  1.465
methodologyOnline Panel/Text-to-Web                      1.856
methodologyProbability Panel                             1.504
sample_size                                              1.217
stateCalifornia                                          7.773
stateConnecticut                                         2.289
stateFlorida                                            -4.236
stateGeorgia                                             0.604
stateIndiana                                            -2.754
stateIowa                                               -1.104
stateMaine                                               5.486
stateMaine CD-1                                         10.547
stateMaine CD-2                                          0.926
stateMaryland                                           12.727
stateMassachusetts                                      11.472
stateMichigan                                            1.966
stateMinnesota                                           3.246
stateMissouri                                           -2.383
stateMontana                                            -6.284
stateNational                                            2.018
stateNebraska                                           -5.046
stateNebraska CD-2                                       3.830
stateNevada                                              1.873
stateNew Hampshire                                       4.368
stateNew Mexico                                          3.393
stateNew York                                            5.605
stateNorth Carolina                                      2.694
stateOhio                                               -2.794
statePennsylvania                                        3.428
stateRhode Island                                        5.803
stateSouth Carolina                                     -0.523
stateTexas                                              -2.582
stateVermont                                            12.619
stateVirginia                                            3.450
stateWashington                                          4.202
stateWisconsin                                           4.457
                                                      Pr(>|t|)
(Intercept)                                            < 2e-16 ***
pollscore                                             0.109903
days_taken_from_election                              2.17e-09 ***
methodologyIVR                                        0.261222
methodologyIVR/Online Panel                           0.176180
methodologyIVR/Online Panel/Text-to-Web               0.058473 .
```

```
methodologyIVR/Text-to-Web                                          0.372012
methodologyLive Phone                                               0.187906
methodologyLive Phone/Email                                         0.101535
methodologyLive Phone/Online Panel                                  0.826382
methodologyLive Phone/Online Panel/Text                             0.109472
methodologyLive Phone/Online Panel/Text-to-Web                      0.037660 *
methodologyLive Phone/Probability Panel                             0.193727
methodologyLive Phone/Text-to-Web                                   0.070983 .
methodologyLive Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone 0.133109
methodologyOnline Ad                                                0.129030
methodologyOnline Panel                                             0.143708
methodologyOnline Panel/Text-to-Web                                 0.064126 .
methodologyProbability Panel                                        0.133272
sample_size                                                         0.224107
stateCalifornia                                                     4.95e-14 ***
stateConnecticut                                                    0.022533 *
stateFlorida                                                        2.75e-05 ***
stateGeorgia                                                        0.546026
stateIndiana                                                        0.006112 **
stateIowa                                                           0.270273
stateMaine                                                          6.77e-08 ***
stateMaine CD-1                                                      < 2e-16 ***
stateMaine CD-2                                                     0.354977
stateMaryland                                                        < 2e-16 ***
stateMassachusetts                                                   < 2e-16 ***
stateMichigan                                                       0.049869 *
stateMinnesota                                                      0.001255 **
stateMissouri                                                       0.017584 *
stateMontana                                                        7.60e-10 ***
stateNational                                                       0.044149 *
stateNebraska                                                       6.47e-07 ***
stateNebraska CD-2                                                  0.000145 ***
stateNevada                                                         0.061684 .
stateNew Hampshire                                                  1.55e-05 ***
stateNew Mexico                                                     0.000751 ***
stateNew York                                                       3.57e-08 ***
stateNorth Carolina                                                 0.007318 **
stateOhio                                                           0.005423 **
statePennsylvania                                                   0.000661 ***
stateRhode Island                                                   1.20e-08 ***
stateSouth Carolina                                                 0.601051
stateTexas                                                          0.010129 *
stateVermont                                                         < 2e-16 ***
```

```
stateVirginia                                                    0.000611 ***
stateWashington                                                  3.17e-05 ***
stateWisconsin                                                   1.04e-05 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 2.346 on 466 degrees of freedom
Multiple R-squared:  0.7203,    Adjusted R-squared:  0.6897
F-statistic: 23.53 on 51 and 466 DF,  p-value: < 2.2e-16
```

```r
just_harris_data <- just_harris_data |> mutate(fitted_value = predict(model_MLR),  num_harris

predictions = predict(model_MLR, just_harris_data)

ggplot(just_harris_data, aes(x = end_date)) +
  geom_point(aes(y = pct), color = "black") +
  geom_line(aes(y = fitted_value), color = "blue", linetype = "dotted") +
  facet_wrap(vars(methodology)) +
  theme_classic() +
  labs(y = "Harris percent", x = "Date", title = "Linear Model: pct ~ end_date + pollster")
```

```
`geom_line()`: Each group consists of only one observation.
i Do you need to adjust the group aesthetic?
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i Do you need to adjust the group aesthetic?

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
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Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <88>
```

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conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <88>

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conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <e6>
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conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <88>

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conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <e6>

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conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <9c>

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conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <88>

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conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <e6>

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conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <9c>
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conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <88>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <88>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <88>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <88>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <9c>
```

```
Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <88>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <88>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '8 ' in 'mbcsToSbcs': dot substituted for <88>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <e6>

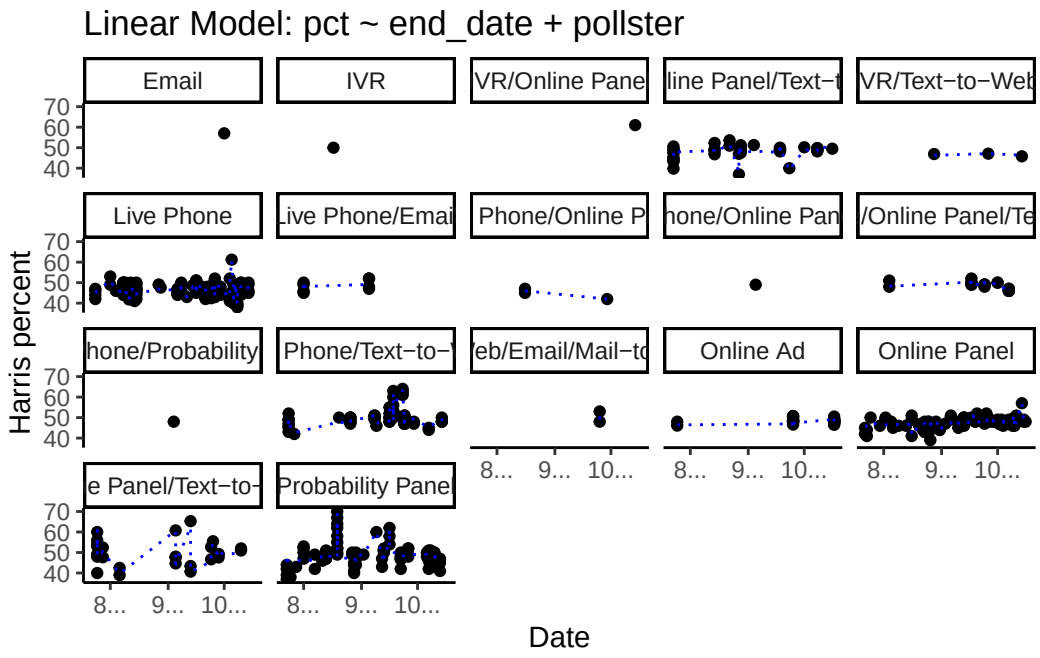
Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '9 ' in 'mbcsToSbcs': dot substituted for <88>

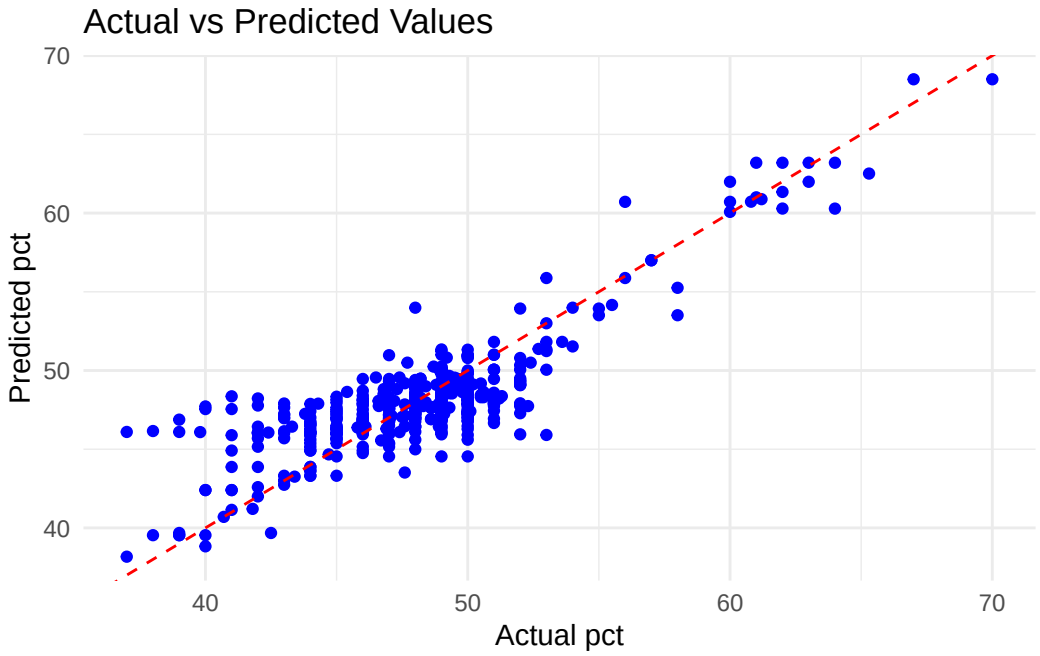
Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <e6>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <9c>

Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
conversion failure on '10 ' in 'mbcsToSbcs': dot substituted for <88>
```




```
ggplot(just_harris_data, aes(x = pct, y = fitted_value)) +
  geom_point(color = 'blue') +
  geom_abline(intercept = 0, slope = 1, linetype = "dashed", color = "red") +
  labs(title = "Actual vs Predicted Values",
       x = "Actual pct",
       y = "Predicted pct") +
  theme_minimal()
```




```
baye_model_data = just_harris_data
baye_model_data$pct = as.factor(baye_model_data$pct)
baye_model_data$pollscore = as.factor(baye_model_data$pollscore)
baye_model_data$days_taken_from_election = as.factor(baye_model_data$days_taken_from_electio
baye_model_data$methodology = as.factor(baye_model_data$methodology)
baye_model_data$pct <- as.numeric(baye_model_data$pct)
# Define the Bayesian model with brms

formula <- pct ~ pollscore + days_taken_from_election + (1 | methodology) + (1 | state)

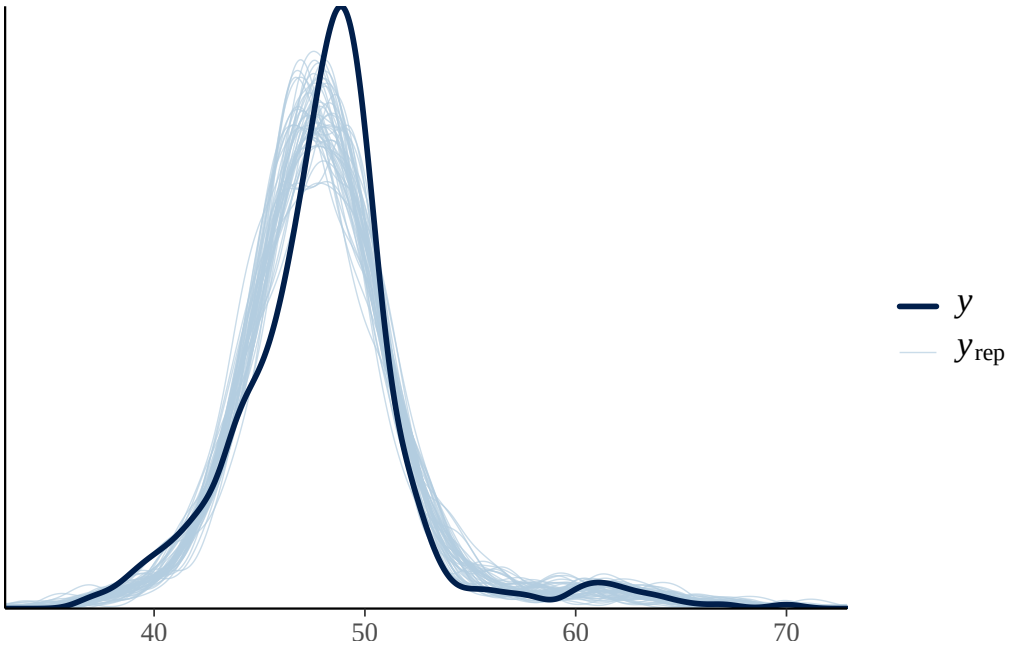
priors = normal(0, 2.5, autoscale = TRUE)

bayesian_model_1 <- stan_glmer(
  formula = formula,
  data = just_harris_data,
  family = gaussian(),
  prior = priors,
  prior_intercept = priors,
  seed = 123,
  cores = 4,
  adapt_delta = 0.95
)
```

```
Warning: Bulk Effective Samples Size (ESS) is too low, indicating posterior means and medians
```

```
Running the chains for more iterations may help. See
https://mc-stan.org/misc/warnings.html#bulk-ess
```

```
pp_check(bayesian_model_1)
```




```
summary(bayesian_model_1)
```

```
Model Info:
 function:     stan_glmer
 family:       gaussian [identity]
 formula:      pct ~ pollscore + days_taken_from_election + (1 | methodology) +
       (1 | state)
 algorithm:    sampling
 sample:       4000 (posterior sample size)
 priors:       see help('prior_summary')
 observations: 518
 groups:       state (33), methodology (17)

Estimates:
                                                                          mean
(Intercept)                                                              51.7
pollscore                                                                 0.8
```

days_taken_from_election	0.0
b[(Intercept) state:Arizona]	-2.5
b[(Intercept) state:California]	9.6
b[(Intercept) state:Connecticut]	2.6
b[(Intercept) state:Florida]	-6.1
b[(Intercept) state:Georgia]	-2.2
b[(Intercept) state:Indiana]	-8.1
b[(Intercept) state:Iowa]	-4.7
b[(Intercept) state:Maine]	4.6
b[(Intercept) state:Maine_CD-1]	11.2
b[(Intercept) state:Maine_CD-2]	-1.5
b[(Intercept) state:Maryland]	12.2
b[(Intercept) state:Massachusetts]	11.4
b[(Intercept) state:Michigan]	-1.4
b[(Intercept) state:Minnesota]	0.8
b[(Intercept) state:Missouri]	-6.3
b[(Intercept) state:Montana]	-9.0
b[(Intercept) state:National]	-1.5
b[(Intercept) state:Nebraska]	-10.4
b[(Intercept) state:Nebraska_CD-2]	1.5
b[(Intercept) state:Nevada]	-1.2
b[(Intercept) state:New_Hampshire]	1.9
b[(Intercept) state:New_Mexico]	2.3
b[(Intercept) state:New_York]	3.7
b[(Intercept) state:North_Carolina]	-1.2
b[(Intercept) state:Ohio]	-4.9
b[(Intercept) state:Pennsylvania]	-0.7
b[(Intercept) state:Rhode_Island]	5.4
b[(Intercept) state:South_Carolina]	-6.6
b[(Intercept) state:Texas]	-4.6
b[(Intercept) state:Vermont]	18.4
b[(Intercept) state:Virginia]	0.3
b[(Intercept) state:Washington]	6.6
b[(Intercept) state:Wisconsin]	0.0
b[(Intercept) methodology:Email]	-0.3
b[(Intercept) methodology:IVR]	0.0
b[(Intercept) methodology:IVR/Online_Panel]	0.1
b[(Intercept) methodology:IVR/Online_Panel/Text-to-Web]	0.7
b[(Intercept) methodology:IVR/Text-to-Web]	-0.5
b[(Intercept) methodology:Live_Phone]	-0.8
b[(Intercept) methodology:Live_Phone/Email]	0.1
b[(Intercept) methodology:Live_Phone/Online_Panel]	-0.7
b[(Intercept) methodology:Live_Phone/Online_Panel/Text]	0.2

b[(Intercept) methodology:Live_Phone/Online_Panel/Text-to-Web]	1.0
b[(Intercept) methodology:Live_Phone/Probability_Panel]	0.0
b[(Intercept) methodology:Live_Phone/Text-to-Web]	0.6
b[(Intercept) methodology:Live_Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone]	0.1
b[(Intercept) methodology:Online_Ad]	-0.1
b[(Intercept) methodology:Online_Panel]	-0.3
b[(Intercept) methodology:Online_Panel/Text-to-Web]	0.6
b[(Intercept) methodology:Probability_Panel]	-0.2
sigma	2.4
Sigma[state:(Intercept),(Intercept)]	46.5
Sigma[methodology:(Intercept),(Intercept)]	0.7
	sd
(Intercept)	1.3
pollscore	0.4
days_taken_from_election	0.0
b[(Intercept) state:Arizona]	1.3
b[(Intercept) state:California]	1.7
b[(Intercept) state:Connecticut]	2.5
b[(Intercept) state:Florida]	1.4
b[(Intercept) state:Georgia]	1.3
b[(Intercept) state:Indiana]	2.5
b[(Intercept) state:Iowa]	2.4
b[(Intercept) state:Maine]	1.7
b[(Intercept) state:Maine_CD-1]	1.7
b[(Intercept) state:Maine_CD-2]	1.6
b[(Intercept) state:Maryland]	1.6
b[(Intercept) state:Massachusetts]	1.7
b[(Intercept) state:Michigan]	1.3
b[(Intercept) state:Minnesota]	1.5
b[(Intercept) state:Missouri]	2.0
b[(Intercept) state:Montana]	1.5
b[(Intercept) state:National]	1.2
b[(Intercept) state:Nebraska]	2.0
b[(Intercept) state:Nebraska_CD-2]	1.5
b[(Intercept) state:Nevada]	1.4
b[(Intercept) state:New_Hampshire]	1.5
b[(Intercept) state:New_Mexico]	1.8
b[(Intercept) state:New_York]	1.6
b[(Intercept) state:North_Carolina]	1.3
b[(Intercept) state:Ohio]	1.4
b[(Intercept) state:Pennsylvania]	1.2
b[(Intercept) state:Rhode_Island]	1.8
b[(Intercept) state:South_Carolina]	2.6

b[(Intercept) state:Texas]	1.4
b[(Intercept) state:Vermont]	2.1
b[(Intercept) state:Virginia]	1.5
b[(Intercept) state:Washington]	2.5
b[(Intercept) state:Wisconsin]	1.3
b[(Intercept) methodology:Email]	0.8
b[(Intercept) methodology:IVR]	0.8
b[(Intercept) methodology:IVR/Online_Panel]	0.8
b[(Intercept) methodology:IVR/Online_Panel/Text-to-Web]	0.4
b[(Intercept) methodology:IVR/Text-to-Web]	0.7
b[(Intercept) methodology:Live_Phone]	0.3
b[(Intercept) methodology:Live_Phone/Email]	0.6
b[(Intercept) methodology:Live_Phone/Online_Panel]	0.8
b[(Intercept) methodology:Live_Phone/Online_Panel/Text]	0.8
b[(Intercept) methodology:Live_Phone/Online_Panel/Text-to-Web]	0.5
b[(Intercept) methodology:Live_Phone/Probability_Panel]	0.8
b[(Intercept) methodology:Live_Phone/Text-to-Web]	0.4
b[(Intercept) methodology:Live_Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone]	0.7
b[(Intercept) methodology:Online_Ad]	0.5
b[(Intercept) methodology:Online_Panel]	0.4
b[(Intercept) methodology:Online_Panel/Text-to-Web]	0.5
b[(Intercept) methodology:Probability_Panel]	0.4
sigma	0.1
Sigma[state:(Intercept),(Intercept)]	12.1
Sigma[methodology:(Intercept),(Intercept)]	0.6
	10%
(Intercept)	50.0
pollscore	0.3
days_taken_from_election	0.0
b[(Intercept) state:Arizona]	-4.1
b[(Intercept) state:California]	7.5
b[(Intercept) state:Connecticut]	-0.6
b[(Intercept) state:Florida]	-7.9
b[(Intercept) state:Georgia]	-3.8
b[(Intercept) state:Indiana]	-11.3
b[(Intercept) state:Iowa]	-7.7
b[(Intercept) state:Maine]	2.5
b[(Intercept) state:Maine_CD-1]	9.0
b[(Intercept) state:Maine_CD-2]	-3.5
b[(Intercept) state:Maryland]	10.1
b[(Intercept) state:Massachusetts]	9.3
b[(Intercept) state:Michigan]	-3.0
b[(Intercept) state:Minnesota]	-1.2

b[(Intercept) state:Missouri]	-8.8
b[(Intercept) state:Montana]	-11.0
b[(Intercept) state:National]	-3.0
b[(Intercept) state:Nebraska]	-13.0
b[(Intercept) state:Nebraska_CD-2]	-0.4
b[(Intercept) state:Nevada]	-2.9
b[(Intercept) state:New_Hampshire]	0.1
b[(Intercept) state:New_Mexico]	0.1
b[(Intercept) state:New_York]	1.7
b[(Intercept) state:North_Carolina]	-2.7
b[(Intercept) state:Ohio]	-6.7
b[(Intercept) state:Pennsylvania]	-2.3
b[(Intercept) state:Rhode_Island]	3.3
b[(Intercept) state:South_Carolina]	-9.9
b[(Intercept) state:Texas]	-6.4
b[(Intercept) state:Vermont]	15.7
b[(Intercept) state:Virginia]	-1.6
b[(Intercept) state:Washington]	3.4
b[(Intercept) state:Wisconsin]	-1.6
b[(Intercept) methodology:Email]	-1.4
b[(Intercept) methodology:IVR]	-1.0
b[(Intercept) methodology:IVR/Online_Panel]	-0.8
b[(Intercept) methodology:IVR/Online_Panel/Text-to-Web]	0.1
b[(Intercept) methodology:IVR/Text-to-Web]	-1.4
b[(Intercept) methodology:Live_Phone]	-1.2
b[(Intercept) methodology:Live_Phone/Email]	-0.6
b[(Intercept) methodology:Live_Phone/Online_Panel]	-1.8
b[(Intercept) methodology:Live_Phone/Online_Panel/Text]	-0.8
b[(Intercept) methodology:Live_Phone/Online_Panel/Text-to-Web]	0.4
b[(Intercept) methodology:Live_Phone/Probability_Panel]	-1.0
b[(Intercept) methodology:Live_Phone/Text-to-Web]	0.1
b[(Intercept) methodology:Live_Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone]	-0.8
b[(Intercept) methodology:Online_Ad]	-0.7
b[(Intercept) methodology:Online_Panel]	-0.8
b[(Intercept) methodology:Online_Panel/Text-to-Web]	-0.1
b[(Intercept) methodology:Probability_Panel]	-0.6
sigma	2.3
Sigma[state:(Intercept),(Intercept)]	32.9
Sigma[methodology:(Intercept),(Intercept)]	0.2
	50%
(Intercept)	51.7
pollscore	0.8
days_taken_from_election	0.0

b[(Intercept) state:Arizona]	-2.5
b[(Intercept) state:California]	9.6
b[(Intercept) state:Connecticut]	2.6
b[(Intercept) state:Florida]	-6.1
b[(Intercept) state:Georgia]	-2.3
b[(Intercept) state:Indiana]	-8.1
b[(Intercept) state:Iowa]	-4.7
b[(Intercept) state:Maine]	4.5
b[(Intercept) state:Maine_CD-1]	11.1
b[(Intercept) state:Maine_CD-2]	-1.5
b[(Intercept) state:Maryland]	12.2
b[(Intercept) state:Massachusetts]	11.4
b[(Intercept) state:Michigan]	-1.4
b[(Intercept) state:Minnesota]	0.8
b[(Intercept) state:Missouri]	-6.3
b[(Intercept) state:Montana]	-9.0
b[(Intercept) state:National]	-1.5
b[(Intercept) state:Nebraska]	-10.4
b[(Intercept) state:Nebraska_CD-2]	1.5
b[(Intercept) state:Nevada]	-1.2
b[(Intercept) state:New_Hampshire]	1.9
b[(Intercept) state:New_Mexico]	2.3
b[(Intercept) state:New_York]	3.8
b[(Intercept) state:North_Carolina]	-1.2
b[(Intercept) state:Ohio]	-4.9
b[(Intercept) state:Pennsylvania]	-0.8
b[(Intercept) state:Rhode_Island]	5.4
b[(Intercept) state:South_Carolina]	-6.6
b[(Intercept) state:Texas]	-4.6
b[(Intercept) state:Vermont]	18.3
b[(Intercept) state:Virginia]	0.2
b[(Intercept) state:Washington]	6.5
b[(Intercept) state:Wisconsin]	0.0
b[(Intercept) methodology:Email]	-0.3
b[(Intercept) methodology:IVR]	0.0
b[(Intercept) methodology:IVR/Online_Panel]	0.1
b[(Intercept) methodology:IVR/Online_Panel/Text-to-Web]	0.7
b[(Intercept) methodology:IVR/Text-to-Web]	-0.4
b[(Intercept) methodology:Live_Phone]	-0.8
b[(Intercept) methodology:Live_Phone/Email]	0.1
b[(Intercept) methodology:Live_Phone/Online_Panel]	-0.6
b[(Intercept) methodology:Live_Phone/Online_Panel/Text]	0.1
b[(Intercept) methodology:Live_Phone/Online_Panel/Text-to-Web]	1.0

b[(Intercept) methodology:Live_Phone/Probability_Panel]	0.0
b[(Intercept) methodology:Live_Phone/Text-to-Web]	0.6
b[(Intercept) methodology:Live_Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone]	0.1
b[(Intercept) methodology:Online_Ad]	-0.1
b[(Intercept) methodology:Online_Panel]	-0.3
b[(Intercept) methodology:Online_Panel/Text-to-Web]	0.5
b[(Intercept) methodology:Probability_Panel]	-0.2
sigma	2.4
Sigma[state:(Intercept),(Intercept)]	44.6
Sigma[methodology:(Intercept),(Intercept)]	0.6
	90%
(Intercept)	53.3
pollscore	1.4
days_taken_from_election	0.0
b[(Intercept) state:Arizona]	-1.0
b[(Intercept) state:California]	11.8
b[(Intercept) state:Connecticut]	5.7
b[(Intercept) state:Florida]	-4.2
b[(Intercept) state:Georgia]	-0.7
b[(Intercept) state:Indiana]	-4.9
b[(Intercept) state:Iowa]	-1.6
b[(Intercept) state:Maine]	6.6
b[(Intercept) state:Maine_CD-1]	13.4
b[(Intercept) state:Maine_CD-2]	0.6
b[(Intercept) state:Maryland]	14.2
b[(Intercept) state:Massachusetts]	13.5
b[(Intercept) state:Michigan]	0.2
b[(Intercept) state:Minnesota]	2.7
b[(Intercept) state:Missouri]	-3.8
b[(Intercept) state:Montana]	-7.1
b[(Intercept) state:National]	0.0
b[(Intercept) state:Nebraska]	-7.9
b[(Intercept) state:Nebraska_CD-2]	3.4
b[(Intercept) state:Nevada]	0.5
b[(Intercept) state:New_Hampshire]	3.8
b[(Intercept) state:New_Mexico]	4.6
b[(Intercept) state:New_York]	5.7
b[(Intercept) state:North_Carolina]	0.4
b[(Intercept) state:Ohio]	-3.0
b[(Intercept) state:Pennsylvania]	0.8
b[(Intercept) state:Rhode_Island]	7.7
b[(Intercept) state:South_Carolina]	-3.4
b[(Intercept) state:Texas]	-2.8

```
b[(Intercept) state:Vermont]                                                  21.1
b[(Intercept) state:Virginia]                                                  2.1
b[(Intercept) state:Washington]                                                9.9
b[(Intercept) state:Wisconsin]                                                 1.5
b[(Intercept) methodology:Email]                                               0.6
b[(Intercept) methodology:IVR]                                                 0.9
b[(Intercept) methodology:IVR/Online_Panel]                                    1.1
b[(Intercept) methodology:IVR/Online_Panel/Text-to-Web]                        1.2
b[(Intercept) methodology:IVR/Text-to-Web]                                     0.4
b[(Intercept) methodology:Live_Phone]                                         -0.3
b[(Intercept) methodology:Live_Phone/Email]                                    0.9
b[(Intercept) methodology:Live_Phone/Online_Panel]                             0.3
b[(Intercept) methodology:Live_Phone/Online_Panel/Text]                        1.1
b[(Intercept) methodology:Live_Phone/Online_Panel/Text-to-Web]                 1.7
b[(Intercept) methodology:Live_Phone/Probability_Panel]                        1.0
b[(Intercept) methodology:Live_Phone/Text-to-Web]                              1.1
b[(Intercept) methodology:Live_Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone]  1.0
b[(Intercept) methodology:Online_Ad]                                           0.5
b[(Intercept) methodology:Online_Panel]                                        0.2
b[(Intercept) methodology:Online_Panel/Text-to-Web]                            1.2
b[(Intercept) methodology:Probability_Panel]                                   0.3
sigma                                                                          2.5
Sigma[state:(Intercept),(Intercept)]                                          62.2
Sigma[methodology:(Intercept),(Intercept)]                                     1.4

Fit Diagnostics:
           mean   sd   10%   50%   90%
mean_PPD 48.1    0.1 48.0  48.1  48.3

The mean_ppd is the sample average posterior predictive distribution of the outcome variable

MCMC diagnostics
                                                                              mcse
(Intercept)                                                                   0.1
pollscore                                                                     0.0
days_taken_from_election                                                      0.0
b[(Intercept) state:Arizona]                                                  0.1
b[(Intercept) state:California]                                               0.1
b[(Intercept) state:Connecticut]                                              0.1
b[(Intercept) state:Florida]                                                  0.1
b[(Intercept) state:Georgia]                                                  0.1
b[(Intercept) state:Indiana]                                                  0.1
b[(Intercept) state:Iowa]                                                     0.1
```

```
b[(Intercept) state:Maine]                                                    0.1
b[(Intercept) state:Maine_CD-1]                                               0.1
b[(Intercept) state:Maine_CD-2]                                               0.1
b[(Intercept) state:Maryland]                                                 0.1
b[(Intercept) state:Massachusetts]                                            0.1
b[(Intercept) state:Michigan]                                                 0.1
b[(Intercept) state:Minnesota]                                                0.1
b[(Intercept) state:Missouri]                                                 0.1
b[(Intercept) state:Montana]                                                  0.1
b[(Intercept) state:National]                                                 0.1
b[(Intercept) state:Nebraska]                                                 0.1
b[(Intercept) state:Nebraska_CD-2]                                            0.1
b[(Intercept) state:Nevada]                                                   0.1
b[(Intercept) state:New_Hampshire]                                            0.1
b[(Intercept) state:New_Mexico]                                               0.1
b[(Intercept) state:New_York]                                                 0.1
b[(Intercept) state:North_Carolina]                                           0.1
b[(Intercept) state:Ohio]                                                     0.1
b[(Intercept) state:Pennsylvania]                                             0.1
b[(Intercept) state:Rhode_Island]                                             0.1
b[(Intercept) state:South_Carolina]                                           0.1
b[(Intercept) state:Texas]                                                    0.1
b[(Intercept) state:Vermont]                                                  0.1
b[(Intercept) state:Virginia]                                                 0.1
b[(Intercept) state:Washington]                                               0.1
b[(Intercept) state:Wisconsin]                                                0.1
b[(Intercept) methodology:Email]                                              0.0
b[(Intercept) methodology:IVR]                                                0.0
b[(Intercept) methodology:IVR/Online_Panel]                                   0.0
b[(Intercept) methodology:IVR/Online_Panel/Text-to-Web]                       0.0
b[(Intercept) methodology:IVR/Text-to-Web]                                    0.0
b[(Intercept) methodology:Live_Phone]                                         0.0
b[(Intercept) methodology:Live_Phone/Email]                                   0.0
b[(Intercept) methodology:Live_Phone/Online_Panel]                            0.0
b[(Intercept) methodology:Live_Phone/Online_Panel/Text]                       0.0
b[(Intercept) methodology:Live_Phone/Online_Panel/Text-to-Web]                0.0
b[(Intercept) methodology:Live_Phone/Probability_Panel]                       0.0
b[(Intercept) methodology:Live_Phone/Text-to-Web]                             0.0
b[(Intercept) methodology:Live_Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone] 0.0
b[(Intercept) methodology:Online_Ad]                                          0.0
b[(Intercept) methodology:Online_Panel]                                       0.0
b[(Intercept) methodology:Online_Panel/Text-to-Web]                           0.0
b[(Intercept) methodology:Probability_Panel]                                  0.0
```

sigma	0.0
Sigma[state:(Intercept),(Intercept)]	0.4
Sigma[methodology:(Intercept),(Intercept)]	0.0
mean_PPD	0.0
log-posterior	0.3
	Rhat
(Intercept)	1.0
pollscore	1.0
days_taken_from_election	1.0
b[(Intercept) state:Arizona]	1.0
b[(Intercept) state:California]	1.0
b[(Intercept) state:Connecticut]	1.0
b[(Intercept) state:Florida]	1.0
b[(Intercept) state:Georgia]	1.0
b[(Intercept) state:Indiana]	1.0
b[(Intercept) state:Iowa]	1.0
b[(Intercept) state:Maine]	1.0
b[(Intercept) state:Maine_CD-1]	1.0
b[(Intercept) state:Maine_CD-2]	1.0
b[(Intercept) state:Maryland]	1.0
b[(Intercept) state:Massachusetts]	1.0
b[(Intercept) state:Michigan]	1.0
b[(Intercept) state:Minnesota]	1.0
b[(Intercept) state:Missouri]	1.0
b[(Intercept) state:Montana]	1.0
b[(Intercept) state:National]	1.0
b[(Intercept) state:Nebraska]	1.0
b[(Intercept) state:Nebraska_CD-2]	1.0
b[(Intercept) state:Nevada]	1.0
b[(Intercept) state:New_Hampshire]	1.0
b[(Intercept) state:New_Mexico]	1.0
b[(Intercept) state:New_York]	1.0
b[(Intercept) state:North_Carolina]	1.0
b[(Intercept) state:Ohio]	1.0
b[(Intercept) state:Pennsylvania]	1.0
b[(Intercept) state:Rhode_Island]	1.0
b[(Intercept) state:South_Carolina]	1.0
b[(Intercept) state:Texas]	1.0
b[(Intercept) state:Vermont]	1.0
b[(Intercept) state:Virginia]	1.0
b[(Intercept) state:Washington]	1.0
b[(Intercept) state:Wisconsin]	1.0
b[(Intercept) methodology:Email]	1.0

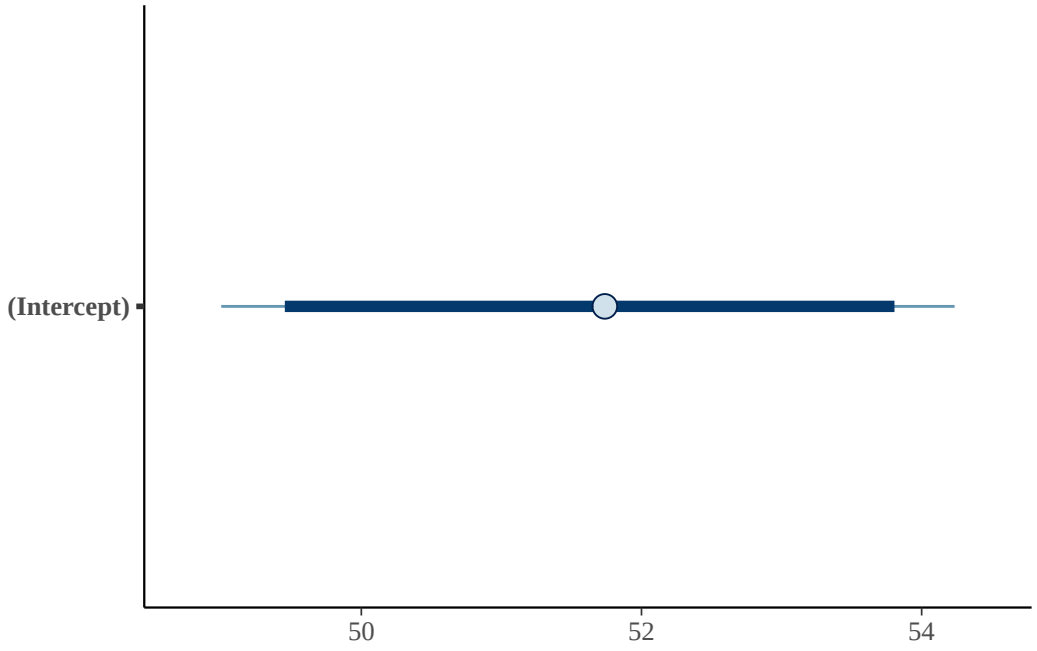
b[(Intercept) methodology:IVR]	1.0
b[(Intercept) methodology:IVR/Online_Panel]	1.0
b[(Intercept) methodology:IVR/Online_Panel/Text-to-Web]	1.0
b[(Intercept) methodology:IVR/Text-to-Web]	1.0
b[(Intercept) methodology:Live_Phone]	1.0
b[(Intercept) methodology:Live_Phone/Email]	1.0
b[(Intercept) methodology:Live_Phone/Online_Panel]	1.0
b[(Intercept) methodology:Live_Phone/Online_Panel/Text]	1.0
b[(Intercept) methodology:Live_Phone/Online_Panel/Text-to-Web]	1.0
b[(Intercept) methodology:Live_Phone/Probability_Panel]	1.0
b[(Intercept) methodology:Live_Phone/Text-to-Web]	1.0
b[(Intercept) methodology:Live_Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone]	1.0
b[(Intercept) methodology:Online_Ad]	1.0
b[(Intercept) methodology:Online_Panel]	1.0
b[(Intercept) methodology:Online_Panel/Text-to-Web]	1.0
b[(Intercept) methodology:Probability_Panel]	1.0
sigma	1.0
Sigma[state:(Intercept),(Intercept)]	1.0
Sigma[methodology:(Intercept),(Intercept)]	1.0
mean_PPD	1.0
log-posterior	1.0
	n_eff
(Intercept)	331
pollscore	5021
days_taken_from_election	6225
b[(Intercept) state:Arizona]	295
b[(Intercept) state:California]	510
b[(Intercept) state:Connecticut]	1460
b[(Intercept) state:Florida]	385
b[(Intercept) state:Georgia]	303
b[(Intercept) state:Indiana]	1363
b[(Intercept) state:Iowa]	1172
b[(Intercept) state:Maine]	485
b[(Intercept) state:Maine_CD-1]	527
b[(Intercept) state:Maine_CD-2]	468
b[(Intercept) state:Maryland]	558
b[(Intercept) state:Massachusetts]	461
b[(Intercept) state:Michigan]	307
b[(Intercept) state:Minnesota]	427
b[(Intercept) state:Missouri]	820
b[(Intercept) state:Montana]	414
b[(Intercept) state:National]	278
b[(Intercept) state:Nebraska]	797

```
b[(Intercept) state:Nebraska_CD-2]                                          384
b[(Intercept) state:Nevada]                                                 361
b[(Intercept) state:New_Hampshire]                                          377
b[(Intercept) state:New_Mexico]                                             562
b[(Intercept) state:New_York]                                               474
b[(Intercept) state:North_Carolina]                                         297
b[(Intercept) state:Ohio]                                                   403
b[(Intercept) state:Pennsylvania]                                           292
b[(Intercept) state:Rhode_Island]                                           616
b[(Intercept) state:South_Carolina]                                        1523
b[(Intercept) state:Texas]                                                  356
b[(Intercept) state:Vermont]                                                678
b[(Intercept) state:Virginia]                                               464
b[(Intercept) state:Washington]                                            1259
b[(Intercept) state:Wisconsin]                                              291
b[(Intercept) methodology:Email]                                           4381
b[(Intercept) methodology:IVR]                                             6075
b[(Intercept) methodology:IVR/Online_Panel]                                5460
b[(Intercept) methodology:IVR/Online_Panel/Text-to-Web]                    2763
b[(Intercept) methodology:IVR/Text-to-Web]                                 4905
b[(Intercept) methodology:Live_Phone]                                      2470
b[(Intercept) methodology:Live_Phone/Email]                                5022
b[(Intercept) methodology:Live_Phone/Online_Panel]                         3153
b[(Intercept) methodology:Live_Phone/Online_Panel/Text]                    5470
b[(Intercept) methodology:Live_Phone/Online_Panel/Text-to-Web]             2881
b[(Intercept) methodology:Live_Phone/Probability_Panel]                    6178
b[(Intercept) methodology:Live_Phone/Text-to-Web]                          2630
b[(Intercept) methodology:Live_Phone/Text-to-Web/Email/Mail-to-Web/Mail-to-Phone] 4898
b[(Intercept) methodology:Online_Ad]                                       3700
b[(Intercept) methodology:Online_Panel]                                    2577
b[(Intercept) methodology:Online_Panel/Text-to-Web]                        3175
b[(Intercept) methodology:Probability_Panel]                               2661
sigma                                                                      5661
Sigma[state:(Intercept),(Intercept)]                                        788
Sigma[methodology:(Intercept),(Intercept)]                                 1671
mean_PPD                                                                   3885
log-posterior                                                               625

For each parameter, mcse is Monte Carlo standard error, n_eff is a crude measure of effective
```

```r
# Plot random effects
plot(bayesian_model_1, pars = "(Intercept)", prob = 0.95)
```

```
Warning: `prob_outer` (0.9) is less than `prob` (0.95)
... Swapping the values of `prob_outer` and `prob`
```




```
# # Transform Biden and Trump's vote shares to fit a beta distribution
# # Biden received 51.3%, Trump received 46.8%, totaling to approximately 98.1% (adjusted her
# total_votes <- 100
# biden_shape1 <- 51.3 / total_votes * 10
# biden_shape2 <- (1 - 51.3 / total_votes) * 10
# trump_shape1 <- 46.8 / total_votes * 10
# trump_shape2 <- (1 - 46.8 / total_votes) * 10

# # Set up priors using beta distributions based on 2020 vote shares
# prior <- c(
#   set_prior(paste0("beta(", biden_shape1, ", ", biden_shape2, ")"), class = "b", coef = "bi
#   set_prior(paste0("beta(", trump_shape1, ", ", trump_shape2, ")"), class = "b", coef = "tr
# )

# # Define the model formula
# formula <- pct ~ pollscore + days_taken_from_election + methodology

# # Run the Bayesian model
# model <- brm(
#   formula = formula,
```

```
#   data = baye_model_data,
#   family = categ0orical(),
#   prior = prior,
#   chains = 4,
#   iter = 2000,
#   warmup = 1000,
#   cores =4
# )

# # Summarize the model
# summary(model)
```

3.2.1 Model justification

We expect a positive relationship between the size of the wings and time spent aloft. In particular…

We can use maths by including latex between dollar signs, for instance θ.

4 Results

Our results are summarized in **?@tbl-modelresults**.

5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

5.2 Second discussion point

Please don't use these as sub-heading labels - change them to be what your point actually is.

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

A Additional data details

B Model details

B.1 Posterior predictive check

In **?@fig-ppcheckandposteriorvsprior-1** we implement a posterior predictive check. This shows...

In **?@fig-ppcheckandposteriorvsprior-2** we compare the posterior with the prior. This shows...

B.2 Diagnostics

?@fig-stanareyouokay-1 is a trace plot. It shows... This suggests...

?@fig-stanareyouokay-2 is a Rhat plot. It shows... This suggests...

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References

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